Mangrove forests for adaptation: potential and vulnerability

Emilia Pramova, Florie Chazarin, Bruno Locatelli

Topic B2. Mangrove forests for adaptation: potential and vulnerability

Emilia Pramova, Florie Chazarin and Bruno Locatelli

USAID FROM THE AMERICAN PEOPLE

CIFOR

Introduction & Objectives

Climate change in mangrove socio-ecological systems

- **Part 1: climate change impacts on mangroves**
  - Main stressors, vulnerability and impacts
  - Adaptation options
- **Part 2: climate change impacts on coastal societies**
  - Main stressors, vulnerability and impacts
  - Adaptation options with mangrove ecosystem services

Part 1. Climate change impacts on mangroves: stressors

Climate stressors

- Sea-level rise
- Hurricanes & storms
- Changes in precipitation

+

Anthropogenic stressors

- Pollution
- Deforestation, land-use conversion
- Sedimentation

= compound effects

Sea-level Rise → Mangroves

- Significant threat to mangroves if it outpaces mangrove sediment accretion and elevation.
- Leads to increased erosion, salinity, and mangrove inundation.
- Forces mangroves to retreat landwards but success of migration depends on multiple factors.
- Site conditions, biodiversity, and the effects of other stressors influence resilience and vulnerability.

Hurricanes & Storms → Mangroves

- **Impacts through waves, wind, sediment burial and changes in water levels.**

- **Direct impacts:**
  - Defoliation, uprooting, mortality
  - Alterations in sediment elevation

- **Indirect impacts:**
  - Upland flooding -> debris flow to mangroves
  - Changes in structure, composition, biodiversity
  - Lower seedling recruitment
  - Increase in vulnerability to SLR

Changes in precipitation → Mangroves

- **Increases in rainfall**
  - Expansion
  - Higher diversity & productivity
  - Increased peat production
- **Decreases in rainfall -> increased salinity**
  - Net losses of peat
  - Decreases in productivity, growth, seedling survival
  - Decreases in biodiversity
  - Contraction of mangrove areas

Anthropogenic pressures

- **Pollution**
  - Low pneumatophore density
  - Stunted growth
- **Excess input of sediment**
  - Burial of roots
  - Reduced productivity, mortality
- **Deforestation & land-use conversion**
  - Reduced biodiversity
  - Modification of soils → slower nutrient cycling
  - Microclimate alteration → increase in ^{0}C
  - Alteration of hydrology → impacts regeneration

Adaptation options for mangroves

- "No regrets" reduction of human stressors
- Catchment management to enhance mangrove sediment elevation
- Ridge-to-reef management
- Managed retreat
- Representation, replication and refugia through a system of protected area networks
- Mangrove rehabilitation
- Regional monitoring network

Part 2. Climate change impacts on coastal societies

Climate stressors

- Sea-level rise
- Hurricanes, storms & coastal floods
- Changes in precipitation

+

Changes in ecosystem services

- Decreased flow due to ecosystem degradation or land-use change
- Restricted access

= compound effects

Sea-level Rise → People

- **Direct impacts**
  - Land loss and inundation, erosion
  - Salt water intrusion
  - Coastal flooding
  - Changes in fish populations & migration patterns
- **Indirect impacts**
  - Migration
  - Conflicts
  - Food insecurity and health problems
  - Infrastructure damage
  - Loss of wetlands & other ecosystems → loss of ecosystem services

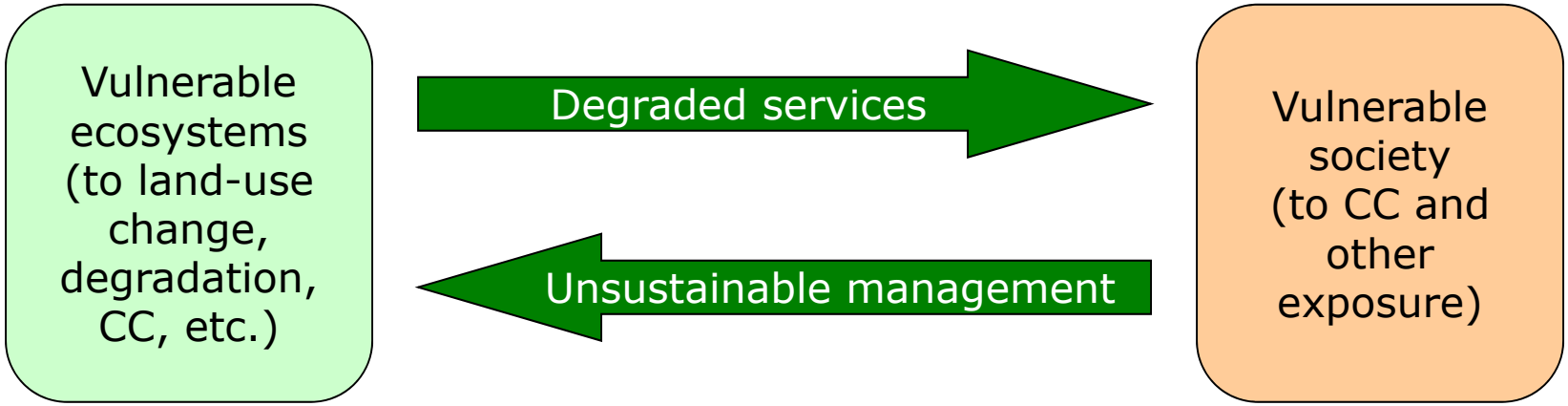
Hurricanes, storms, flood → People

- **Direct impacts**
  - Loss of life and property
  - Damage to infrastructure
  - Loss in agricultural yields and aquaculture
- **Indirect impacts**
  - Population displacement
  - Decline in tourism
  - Food insecurity and health problems
  - Pollution
  - Loss of wetlands & other ecosystems → loss of ecosystem services

Changes in precipitation → People

- **Decreases in precipitation**
  - Fresh water decrease
  - Increases in salinity
  - Losses in yields
- **Intense precipitation events**
  - Coastal flooding and resulting direct & indirect impacts

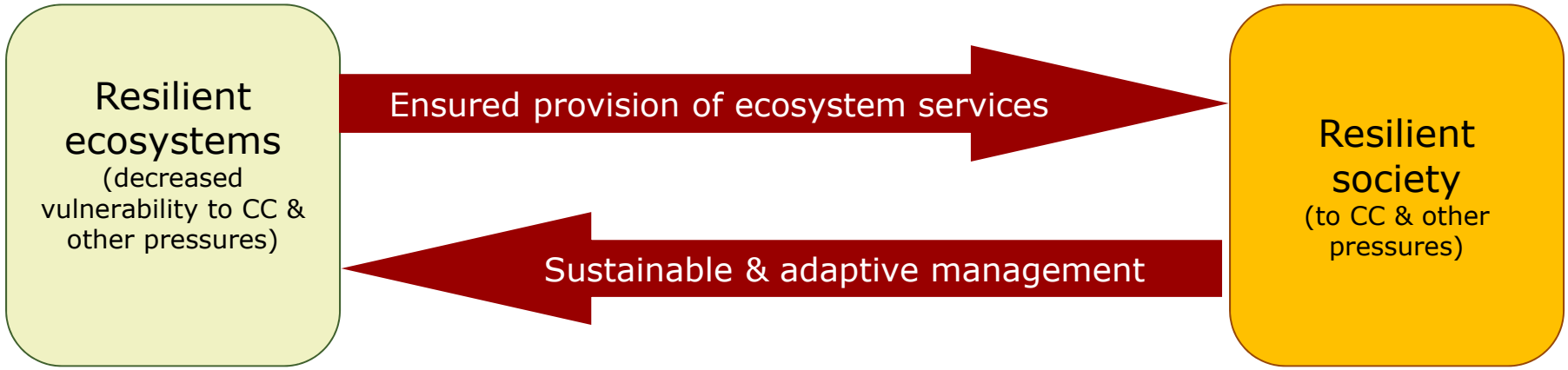
The problem: Vulnerability of coupled social-ecological systems



Mangrove ES for the adaptation of people

- Storm protection (wave energy dissipation, wind buffer)
- Erosion control
- Binding/trapping of sediments
- Coastal flood regulation
- Provision of habitat for fish nurseries
- Provision of products (timber, honey, NTFPs)
- Support of tourism activities
- Accommodation of sea-level rise
- Regulation of flows (nutrients, fresh water, sedimentation) towards seagrasses & corals

Concluding remarks



Points for discussion

- Which drivers of change (climatic, anthropogenic) are the most important in the mangrove socio-ecological systems you are familiar with?
  - What interactions between drivers?
- What is the potential and challenges of using mangrove ecosystem services for the adaptation of people in the areas you work in?

References

Appeaning Addo K, Larbi L, Amisigo B, and Ofori-Danson PK. 2011. Impacts of coastal inundation due to climate change in a cluster of urban coastal communities in Ghana, West Africa. *Remote Sensing 3*(9): 2029–2050.

Badola R and Hussain S. 2005. Valuing ecosystem functions: an empirical study on the storm protection function of Bhitarkanika mangrove ecosystem, India. *Environmental Conservation 32*(1): 85–92.

Baldwin A, Egnotovich M, Ford M, and Platt W. 2001. Regeneration in fringe mangrove forests damaged by Hurricane Andrew. *Plant Ecology 157*(2): 151–164.

Barnett J. 2011. Dangerous climate change in the Pacific Islands: food production and food security. *Regional Environmental Change 11*(1): 229–237.

Cahoon DR, Hensel P, Rybczyk J, McKee KL, Proffitt CE, and Perez BC. 2003. Mass tree mortality leads to mangrove peat collapse at Bay Islands, Honduras after Hurricane Mitch. *Journal of ecology*, *91*(6), 1093–1105.

Das S. 2011. Examining the Storm Protection Services of Mangroves of Orissa during the 1999 Cyclone. *Economic & Political Weekly 46*(24): 61.

Das S, & Vincent JR. 2009. Mangroves protected villages and reduced death toll during Indian super cyclone. *Proceedings of the National Academy of Sciences*, *106*(18), 7357–7360.

Dasgupta S, Laplante B, Meisner, C, Wheeler D, and Yan J. 2009. The impact of sea level rise on developing countries: a comparative analysis. *Climatic Change 93*(3-4): 379–388.

References

Ellison JC. 1999. Impacts of Sediment Burial on Mangroves. *Marine Pollution Bulletin 37*(8–12):420–426. doi:10.1016/S0025-326X(98)00122-2

Ferwerda JG, Ketner P, and McGuinness KA. 2007. Differences in regeneration between hurricane damaged and clear-cut mangrove stands 25 years after clearing. *Hydrobiologia 591*(1):35–45. doi:10.1007/s10750-007-0782-7

Gilman EL, Ellison J, Duke NC, and Field C. 2008. Threats to mangroves from climate change and adaptation options: A review. *Mangrove Ecology – Applications in Forestry and Costal Zone Management 89*(2):237–250. doi:10.1016/j.aquabot.2007.12.009

Haque U, Hashizume M, Kolivras KN, Overgaard HJ, Das B, and Yamamoto, T. 2012. Reduced death rates from cyclones in Bangladesh: what more needs to be done? *Bulletin of the World Health Organization 90*(2):150–156.

Krauss KW, Cahoon DR, Allen JA, Ewel KC, Lynch JC, and Cormier N. 2010. Surface elevation change and susceptibility of different mangrove zones to sea-level rise on pacific high islands of Micronesia. *Ecosystems 13*(1):129–143.

López-Medellín X, Ezcurra E, González-Abraham C, Hak J, Santiago LS, and Sickman JO. 2011. Oceanographic anomalies and sea-level rise drive mangroves inland in the Pacific coast of Mexico. *Journal of Vegetation Science 22*(1):143–151.

Mandura AS. 1997. A mangrove stand under sewage pollution stress: Red Sea. *Mangroves and Salt Marshes 1*(4):255–262. doi:10.1023/A:1009927605517

Martínez Arroyo A, Manzanilla Naim S, and Zavala Hidalgo J. 2011. Vulnerability to climate change of marine and coastal fisheries in México. *Atmósfera 24*(1):103–123.

References

McKee KL, Cahoon DR, and Feller IC. (2007). Caribbean mangroves adjust to rising sea level through biotic controls on change in soil elevation. *Global Ecology and Biogeography 16*(5):545–556.

Neil Adger W. 1999. Social vulnerability to climate change and extremes in coastal Vietnam. *World Development 27*(2):249–269.

Nunn PD, and Mimura N. 1997. Vulnerability of South Pacific island nations to sea-level rise. *Journal of coastal research:*133–151.

Paling E, Kobryn H, and Humphreys G. 2008. Assessing the extent of mangrove change caused by Cyclone Vance in the eastern Exmouth Gulf, northwestern Australia. *Estuarine, coastal and shelf science 77*(4):603–613.

Raha A, Das S, Banerjee K, and Mitra A. 2012. Climate change impacts on Indian Sunderbans: a time series analysis (1924–2008). *Biodiversity and Conservation 21*(5):1289–1307. doi:10.1007/s10531-012-0260-z

Saleem Khan A, Ramachandran A, Usha N, Punitha S, and Selvam V. 2012. Predicted impact of the sea-level rise at Vellar-Coleroon estuarine region of Tamil Nadu coast in India: Mainstreaming adaptation as a coastal zone management option. *Ocean & Coastal Management 69:*327–339.

Sales JrRFM. 2009. Vulnerability and adaptation of coastal communities to climate variability and sea-level rise: their implications for integrated coastal management in Cavite City, Philippines. *Ocean & Coastal Management 52*(7):395–404.

References

Santos LCM, Cunha-Lignon M, Schaeffer-Novelli Y, and Cintrón-Molero G. 2012. Long-term effects of oil pollution in mangrove forests (Baixada Santista, Southeast Brazil) detected using a GIS-based multitemporal analysis of aerial photographs. *Brazilian Journal of Oceanography 60*:159–170.

Sjöling S, Mohammed SM, Lyimo T, and Kyaruzi J. n.d. . Benthic bacterial diversity and nutrient processes in mangroves: impact of deforestation. *Estuarine, Coastal and Shelf Science 63*(3),:397–406.

Swiadek JW. 1997. The impacts of Hurricane Andrew on mangrove coasts in southern Florida: a review. *Journal of coastal research:*242–245.

Tovilla-Hernández C, Espino de la Lanza G, and Orihuela-Belmonte DE. 2001. Impact of logging on a mangrove swamp in south Mexico: cost/benefit analysis. *Rev Biol Trop 49*(2):571–580.

Wang M, Zhang J, Tu Z, Gao X, and Wang W. 2010. Maintenance of estuarine water quality by mangroves occurs during flood periods: A case study of a subtropical mangrove wetland. *Mar Pollut Bull 60*(11):7–7. doi:10.1016/j.marpolbul.2010.07.025

Winterwerp JC. Borst WG, and De Vries MB. 2005. Pilot Study on the Erosion and Rehabilitation of a Mangrove Mud Coast. *Journal of Coastal Research:*223–230. doi:10.2112/03-832A.1

The Sustainable Wetlands Adaptation and Mitigation Program (SWAMP) is a collaborative effort by CIFOR, the USDA Forest Service, and the Oregon State University with support from USAID.

How to cite this file

Pramova E, Chazarin F, and Locatelli B. 2015. Mangrove forest for adaptation: potential and vulnerability [PowerPoint presentation]. In: SWAMP toolbox: Theme B section B2 Retrieved from

Photo credit

Daniel Murdiyarso/CIFOR, Kate Evans/CIFOR, M. Edliadi/CIFOR, Nanang Sujana/CIFOR, Neil Palmer/CIAT, Ricki Martin/Bobo, Rupesh/CIFOR, Sigit Deni Sasmito/CIFOR.